

SPATIAL INFORMATION SYSTEM FOR 3D DOCUMENTATION OF PLAKA, THE HISTORICAL CENTER OF ATHENS

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ABSTRACT:

Old housing areas, such as the historic centers of most European cities, are objects of architectural or cultural interest since they include a large number of historic buildings and monuments dating from various historic periods. Such buildings and monuments together with their access and surrounding areas are often a unified construction total, whose spatial design and operation can be fully recorded and documented by means of a 3D Geographical Information System. The representation of all historic multiple impact and the various phases through years starting from the more recent up to the most old objects can be easily achieved by recording the current condition of the buildings and other historic monuments, the topography and planning characteristics of the surrounding area, and by combining these data with a variety of quality information, such as images, videos, old maps and city plans and other available data. In this paper the background, the available data and their exploitation and the design and implementation schedule of such a task are presented and evaluated.

1. INTRODUCTION

The old city centres are, in most cases, highly visited places with a lot of social and commercial activity. In the effort of the local authorities for exploiting their attractiveness, old city centres become the victims of their beauty. Measures should be taken following careful consideration of all parameters involved. This may only be possible by the use of suitable tools which acquire, store, manage, relate and process all kinds of information in the best possible way.

In order to acquire such information a full documentation of the area is necessary. This integrated documentation comprises the acquisition of all historic, archaeological, architectural, legal and geometric information available. Existing maps and drawings, verbal descriptions, historic photographs and all related material is essential in contributing to this documentation.

Recently, there is a great interest to develop new methods and techniques. Relevant studies and applications have been presented in various symposia, e.g., in CIPA, VAST, 3D-ARCH, FIG or at workshops focuses on the specific topic, e.g. on 'Vision Techniques for Digital Architectural and Archaeological Archives' (Ancona, 2003), 'Vision Technologies Applied to the Rehabilitation of City Centres' (Lisbon 2004), 'Recording, Modeling and Visualization of Cultural Heritage' (Ascona, 2005), etc. The main research fields are:

- The creation of realistic virtual models of architecture and the development of 3D model reconstruction techniques as design and planning tools for the investigation and documenting of remarkable buildings, small sets of buildings or complex historical sites (Stamos and Allen, 2000; Artese et al, 2003; Ioannidis et al, 2004; Lerma and Garcia, 2004; El-Hakim, 2005; Penard et al, 2005). By using special software the creation of virtual flights is possible, which allow the user to discover unique cultural

heritage through Internet; through interactive procedures the user can move freely around the model and obtain information about special features by means of hyperlinks.

- The development of special Geographical Information Systems to manage a protected area or to facilitate the conservation of historical centers (Lohr et al, 2004; Briani et al, 2005; Crespi, 2005; Guarisco, 2005; Lelo and Travaglini, 2005).
- The combined application of aerial and terrestrial, image-based and laser scanning techniques, for the geometric recording, with an emphasis in automation (Gomez and Fernandez, 2003; Visintini et al, 2005; El-Hakim et al, 2006; Ioannidis et al, 2006). In urban areas precision LIDAR shows the existing buildings typically as a raster elevation model. Aerial photographs superposed to the elevation data improve the degree of reality when visualizing buildings in 3D. Draping such models with photographs of facades gives a nearly realistic view on the building structure.

This paper describes an attempt to develop a Spatial Information System for the historical center of Athens, so called Plaka, in Greece. The enhancement of the architectural heritage of Plaka is the research area undertaken by the Directorate of Restoration of Modern and Contemporary Monuments of the Ministry of Culture with the technical assistance of the Laboratory of Photogrammetry of NTUA. Plaka belongs to the greater area of the Acropolis of Athens (Figure 1) and it includes a significant number of important ancient and Byzantine monuments, but also a lot of neoclassical buildings. Plaka is an area protected by a special legislation, which rules the construction development and defines very strict building- and land-use regulations to avoid alteration of the existing characteristic architecture and style.

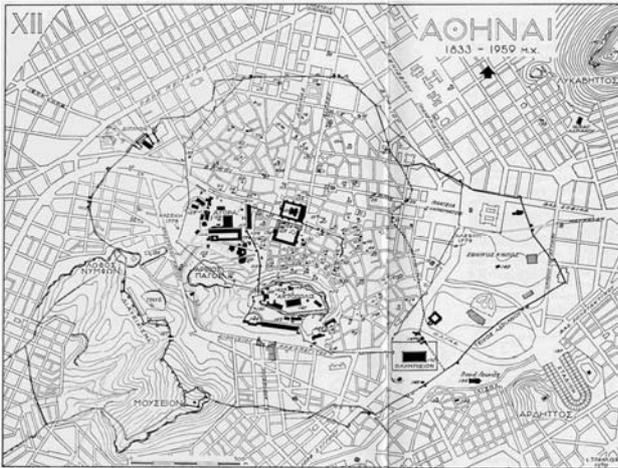


Figure 1: Urban plan for the greater Plaka area, the area which is enclosed by the walls of ancient Athens, as depicted in a early 20th century map (source: Travlos, 1960)

A large number of buildings in Plaka belong to the State; the Hellenic Ministry of Culture is the major real estate owner. Management and control of these properties under current circumstances was very difficult almost impossible since all necessary information for that is not yet recorded. The creation of a Spatial Information System (SIS) is expected to dramatically improve the situation and help to solve the problem. Practically the program aims at the reassessment of the functional use of approximately 104 buildings of the Ministry of Culture in Plaka, most of them neoclassical.

2. THE PLAKA AREA IN ATHENS

2.1 Historical notes

Athens city is continuously inhabited since pre-historic era, with some periods of tense blooming of its power and population, and some other of decline. The city has always been stretched out from foot of the hill, where Acropolis is build on. Historical monuments and ruins are scattered all over the broader area of the current city center; thus, the recording of the housing net and the most important buildings of the city through the various historic periods, is a necessary component of an information system for the documentation of Plaka area. The pre-existing historic, archaeological and architectural studies with detailed geometric and other data are very supportive; by example, Figure 2 shows some maps with the housing net of Athens in various characteristic periods, as they are given, in analog form in (Travlos, 1960).

The Old Quarter of Athens (Plaka area), presents in its urban form all the characteristics of a vernacular urban planning dating to the 18th and 19th centuries. Its proximity to the Acropolis' rock, the co-existence with monuments from different historical periods, most of them constituting archaeological sites and other still functioning like the Byzantine churches, and the presence of a large number of 19th century buildings led the Housing Department of the Ministry of Public Works to formulate a feasible proposal for the preservation and the rehabilitation of the district.

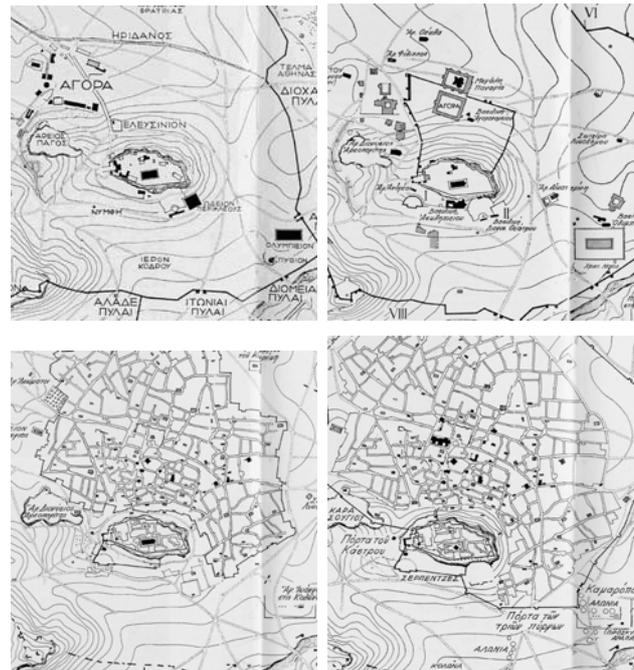


Figure 2: The greater Plaka area at four characteristic historic periods: during the Golden Age (top left), beginning of Byzantine period 5th-6th century (top right), beginning of the Turkish occupation 1456-1687 (bottom left) and at the end of the Turkish occupation 1687-1833 (bottom right)

The first plan was elaborated between 1973 and 1975 and the second one from 1977-78 by interdisciplinary expert teams headed by NTUA Prof. D. Zivas. The main objectives of the studies were firstly to deal with the problems resulting from the degradation of the area and the architectural, functional and social alteration of the area and secondly to elevate the archaeological sites while at the same time preserve its historic course and the way of life of the modern town. The final proposal noted that *“the area needed active protection and preservation and under no circumstances is it to be turned into some sort of museum. Working with the above in mind, the following proposals were formulated: a. preservation of the Quarter in its present urban form, b. integration of monuments and archaeological sites into the living Quarter as a whole, c. establishment and integration of modern urban functions that will enable the Quarter to survive in the future”* (Zivas, 1977).

Insofar it was proposed that Plaka was to become a residential district with a controlled quota of tourist and cultural functions. Certain regulatory and legislative adjustments were suggested which included precise indication of the parts needing protection and establishments of special building rules, land uses and requirements regarding signs or advertising posters. The existing street pattern was retained for pedestrian use and the archaeological excavations were undertaken on a limited scale and were confined in two blocks linking all existing archaeological sites without creating gaps in the main body of the area.

The plan also emphasized the need for restoration and preservation of the neo-classical and vernacular buildings as more than 88.3% of its buildings were distinctive and noteworthy. A legal framework foresaw the listing of all these historical buildings and the possibilities for their repair, structural reinforcement and interior upgrading.

2.2 Current Situation

From 1980-1981 the Directorate of Cultural Buildings and Restoration of Modern Monuments elaborated the project "Plaka" in order to record the existing state of preservation, propose and apply a number of basic principles for the consolidation and restoration of the street façades. The purpose was to harmonize every old domestic establishment of Plaka and its architectural qualities with the new use given to the interior by the owner.

The continuous application of this project and the measures applied had certain spectacular results. Thus the façades of the buildings were revealed and their architectural and artistic merits were enhanced. All these measurements resulted in the creation of a new climate in the neighborhood, which led many residents and owners to repair their houses and use them as residencies, offices and for other commercial activities. As a result, a great number of buildings have been restored on private initiative. Several buildings, belonging to the state, have also been restored and used by the Archaeological Service of the Ministry of Culture, as offices of the Ephorates of Antiquities.

For example, the old Turkish bathhouse (Hammam) has been restored in the 1990's and is now used as a Museum (Figure 3), while another three museums, the Museum of Folk Instruments, the Melina Merkouri Museum and the Greek Folk Art Museum (Figure 4) were housed in important historical buildings, which were restored by the Directorate in the 1990's.



Figure 3: Old Turkish bathhouse - Hammam before (left) and after (right) restoration works

Generally, the Directorate undertook the conservation and the restoration of over 300 modern and contemporary monuments. Among these buildings 104 are owned by the Ministry of Culture, 54 of which have been restored and reused by Public Services and Cultural Organizations, 8 are under restoration and 41 have not yet been restored.

Yet, the development of all that activity and the necessary monitoring and control of the application in the area of building regulations, land uses and other legislative restrictions, made the need for a modern Spatial Information System urgent.

3. THE PROJECT UNDERWAY

For the control, management and monitoring of land development in Plaka according to the existing legal building and land use regulation system, for the tourist and cultural



Figure 4: The Greek Folk Art Museum before (top) and after (bottom) restoration works

development of the area and for the planning of new interventions, the compilation of a research program was proposed with the title: "Development of a special Geographic Information System (SIS) for the documentation and 3D representation of the preserved buildings in the area of Plaka". The contribution of specialists from various disciplines, e.g., Archaeologists, Architects, Surveyor Engineers, Computer Scientists, can be inserted into the SIS, together with all the existing data in the Directorate of Ministry of Culture and the data scattered in other relevant public agencies. The tools provided by modern technology for geometric recording, virtual representation of complex object and for decision making support should be used. Based on the existing condition of the buildings, the urban plan and the natural environment of the area, and with the support of the old historic maps, e.g. Figures 1 and 2 (Travlos, 1960), the representation of the historic sequence will be achieved, through recording and demonstrating the various time phases, starting with the new buildings up the old ones.

The main benefits of this technological intervention are:

- the gradual completion of the restoration and the reuse of the 19th and 20th century monuments of the specific area owned by the Ministry of Culture
- a more effective control of building owned by individuals
- the creation of a useful tour guide of the area with a plentitude of historical, archaeological, architectural and other types of information for the indigenous and the foreign visitors and scientists of various disciplines
- the development of a tool to educate the public and help them to acquire awareness and consciousness of the significance of their urban environment.

In the following the four main phases, planned for the project, are developed.

3.1 Data Collection

The first phase of the project is the compilation of a digital framework for the whole area of Plaka. This includes:

- the detailed recording of the current situation
- the creation of different layers of geometric information, each one of them contains the situation at various time periods, using all available information, e.g., diagrams, maps, or any other geometric data at appropriate scales, such as old plans, existing photogrammetric maps at a scale of 1:500, planimetric maps of specific areas compiled by various public and private agencies, urban plot maps, archaeological surveys, plans of specific monuments, etc.

The utilization of the available large scale aerial photos plays an important role for the creation of integrated surveys, which represent the development of land in the area through time. There is a great number of broad or individual field surveys for the historic center of Athens during the 20th century (of modern buildings or monuments), but also several programmes for air photography. Thus, from 1929 until today more than 14 series of large scale aerial photos have been done (Figure 5). From those, the aerial photos of five different time periods were selected to be used, which were combined with the existing maps produced at the same periods; The result is to provide a powerful tool for monitoring the housing development in the Plaka area certain time intervals, for example every twenty years, i.e. in 1930, 1950, 1970, 1990, and 2006.

Further, stereophotogrammetric processing of those photos will produce 3D geometric information about the construction activity in the area. This will include the urban network and its evolution, the various buildings with information about their height and volume. This document will be the basis for all subsequent actions towards the final goal of the project.



Figure 5: Old aerial photo of Plaka area, taken in 1953

3.2 Creation of a SIS

In the second phase of the project includes the creation of a Spatial Information System (SIS) primarily for the buildings, their data, the qualitative (attributes) and their geometric characteristics. This phase includes the following actions:

- Logical design of the Information System and of the Data Base
- Physical design of the IS
- Data collection, from existing files, field work and the geometric recording, which was made during the first phase of the project
- Acquisition, recording, and management of the above data into the IS, and metadata recording
- Data processing
- Output production and compilation of thematic maps.

The system's architecture allows the integration of additional geometric or other type of information. This includes all sorts of attributes, mainly about the properties of the Hellenic Ministry of Culture. Figure 6 shows a characteristic sample of a thematic map, which was produced from the information inserted into the SIS: the combined representation of the monuments and the properties of the Ministry of Culture with the extent of their restoration and the existing use of the buildings.

Special emphasis is given to the use of a three dimensional (3D) GIS; the acquisition into the system and the visualization of 3D building models, that will be developed during the next phases of the project, is necessary. Thus, the use of ArcGIS of ESRI software with the 3D Analyst extension was chosen.

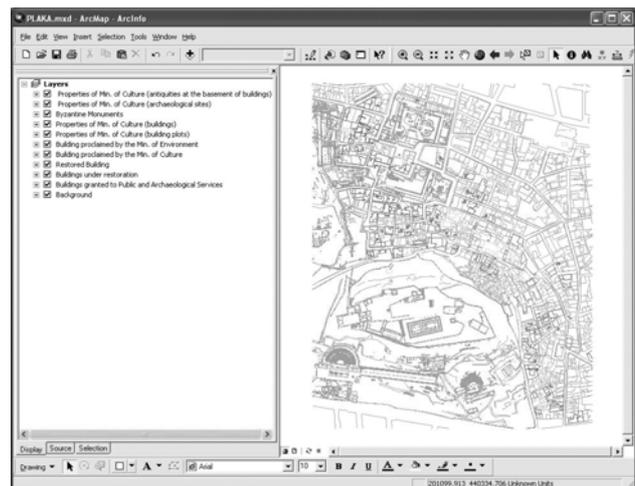


Figure 6: Screen of the SIS which shows the map with the 121 properties of the Ministry of Culture in Plaka

3.3 Three dimensional models of Buildings

The next phase involves the creation of 3D virtual models of the buildings of interest. This stage includes the 3D digital representation and visualization of the constructions in the area. The 3D data of the each building are collected, e.g. through the photogrammetric restitutions of the first phase of the project or field surveys or by laser scanning processes, and the external surfaces and the 3D models of the buildings are created, in a semi-automatic procedure.

For buildings of special architectural or historical interest, additional work is done, which includes:

- terrestrial metric photography of the facades and control point measurements
- photogrammetric rectification or orthophoto production of the facades
- production of 3D photorealistic models.

As a pilot stage, a sub-area of Plaka is selected, in coordination with the responsible Directorate of the Hellenic Ministry of Culture, which consists of two urban blocks with a number of public-owned buildings, where the proposed methodology is fully applied.

3.4 Animation and Visualization

The completion of this project will be achieved through the final phase, in which animations and virtual walk-through paths along selected routes are going to be produced. These works will be done after the finalization of the three first phases of the project and it is scheduled that they will refer to the above mentioned selected sub-area.

An application of 3D animations will be developed; all buildings will be presented in real time and the buildings of special interest will be represented in detail. In this task terrestrial images will be draped on the 3D models produced in previous phases. The level of detail on the 3D models will be such that would enable the users to perform their own actions.

4. CONCLUDING REMARKS

During the recent years there was a significant development of the techniques and the methods used for the 3D geometric documentation of historical monuments; in parallel, software for the management of 3D data in IS, virtual environments and the Internet was developed. These tools pushed the development of 3D city models and especially the detailed models of historical city centers, in various European cities.

The Hellenic Ministry of Culture realized that the creation of such a system for the area of Plaka is necessary; in cooperation with the National Technical University of Athens, the design of a specific project was made and the execution of the first phases is finished. During its application procedure, the results and the products of the created Information System will be analyzed and criticized, together with the difficulties and the problems for the development of the system. This will lead to corrections and adjustments of the whole process for the integrated implementation in the whole area. Finally, some recommendations about the further improvements and the possible perspectives of the system will be given, for a possible use by the Ministry of Culture or other public services and organizations.

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